Implementation of Integrated System Fault Management Capability

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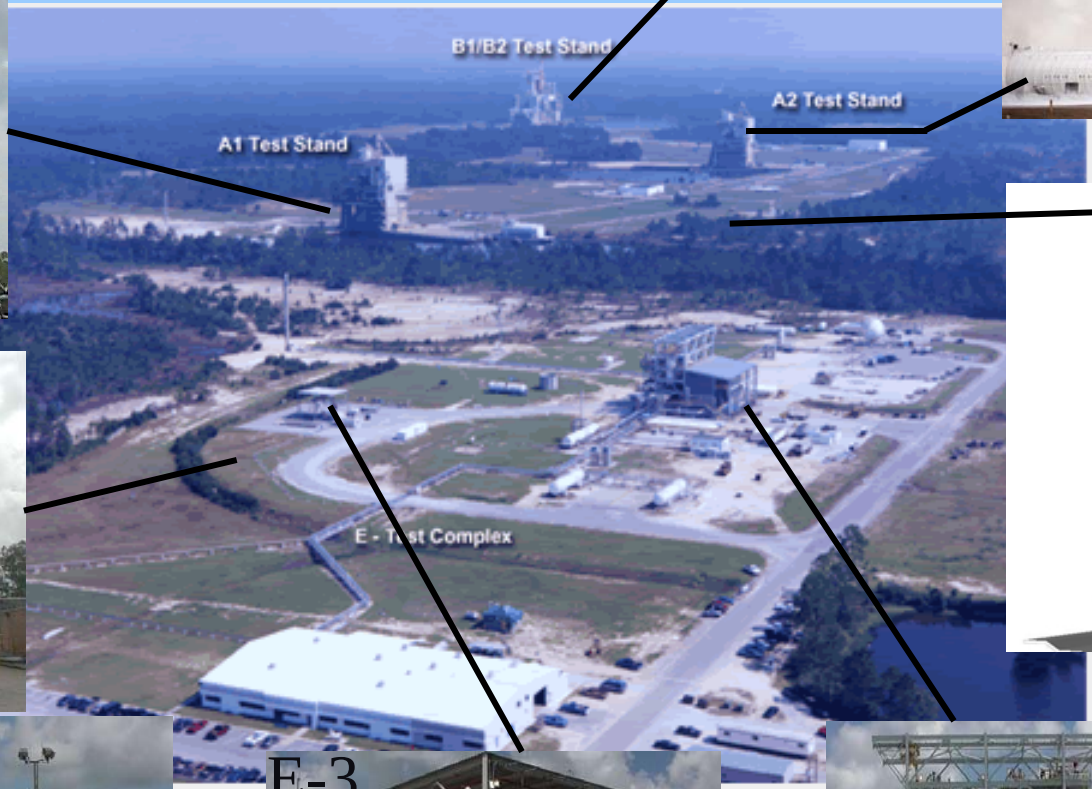
Fault Management to support rocket engine test mission with highly reliable and accurate measurements; while improving availability and life-cycle costs.

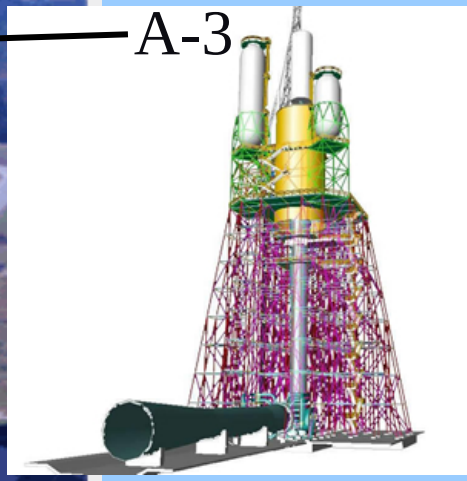
B-1/B-2

A-1



A-2

A-3



E-2

E-3

E-1

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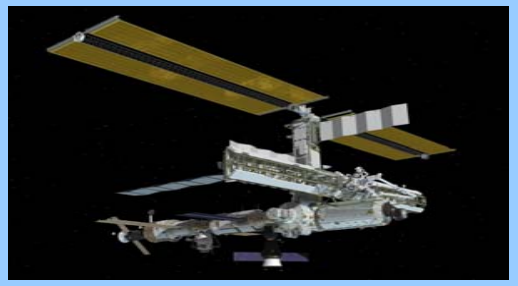
CURRENT FM APPROACH

MOVE CAPABILITY TOWARD LEVELS 2 AND 1

	International Space Station	Rocket Engine Test Stand	
Layer 1 Vehicle/ Test Stand			Signal threshold violation detection
Layer 2 Astronaut/ Test Conductor			Added DIaK from on-board users.
Layer 3 Control Room			Added DIaK from broad group of experts.
Layer 4 Back Control Room			Added DIaK resources from larger community

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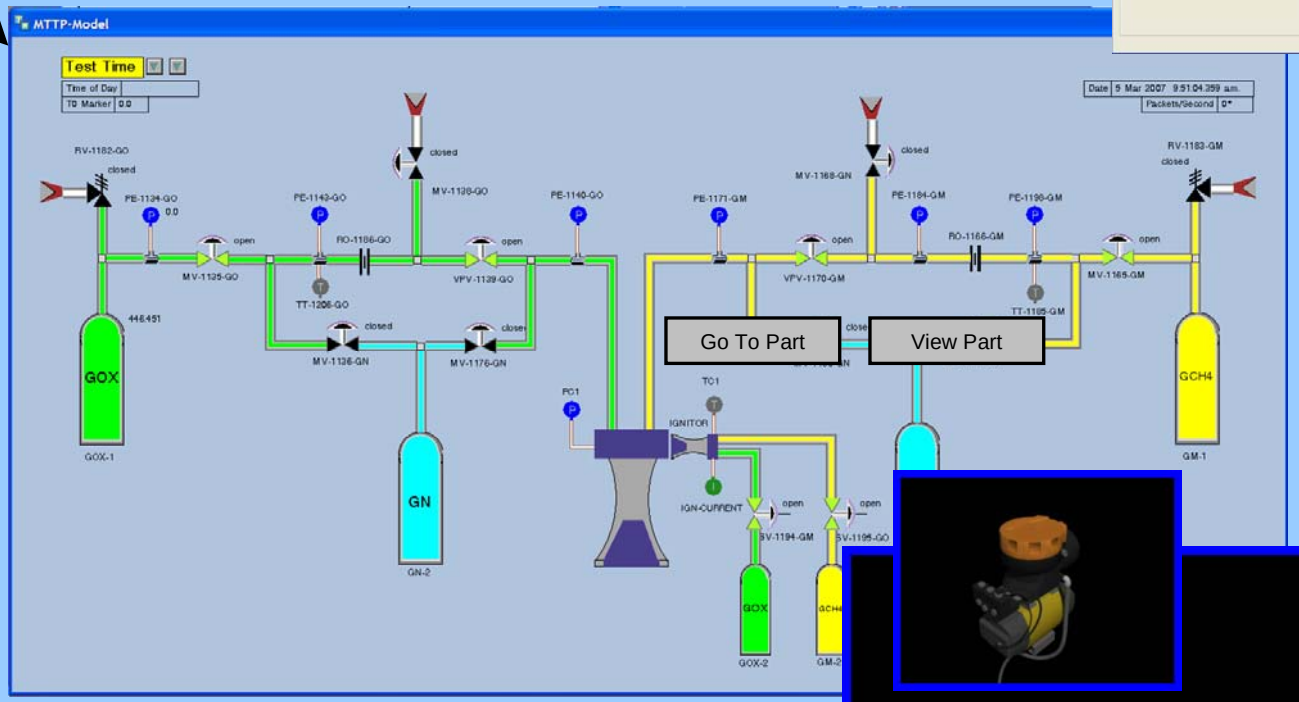
SSC ISFM Capabilities

ISFM Models (Embedded Data, Information, and Knowledge):
MTTP Implementation

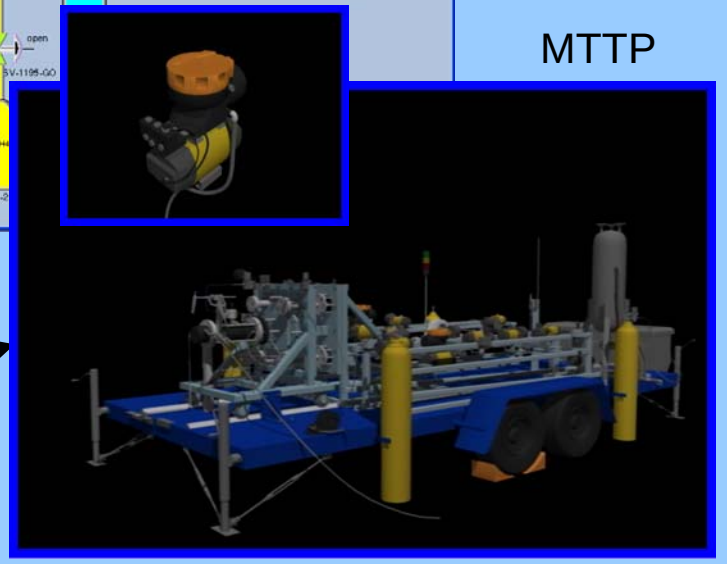
Health Anomaly Database:
Health Electronic Data Sheets
Repository of anomalies

Anomaly Detection:
Leaks, etc.

Intelligent Sensors: IEEE Standard+Health



MTTP



Embedding of Predictive Models

Root Cause Analysis

Integrated Awareness:
3-D Health Visualization of MTTP

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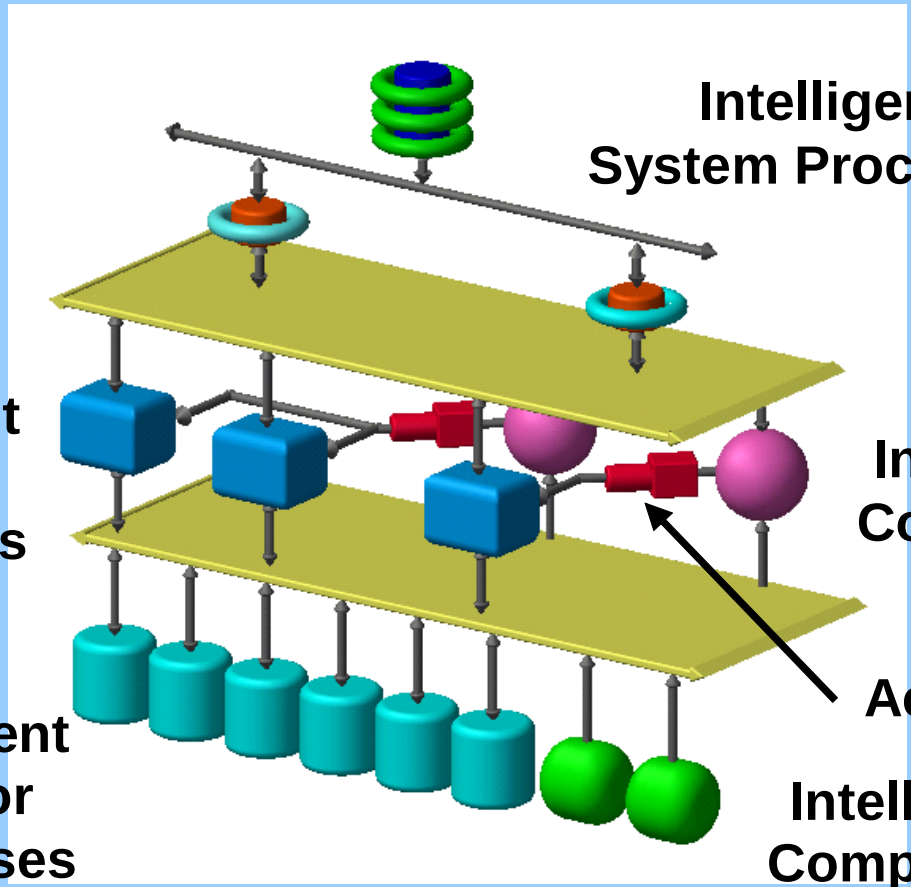
CORE ELEMENTS: Architecture, taxonomy, and ontology (ATO) for DIaK management



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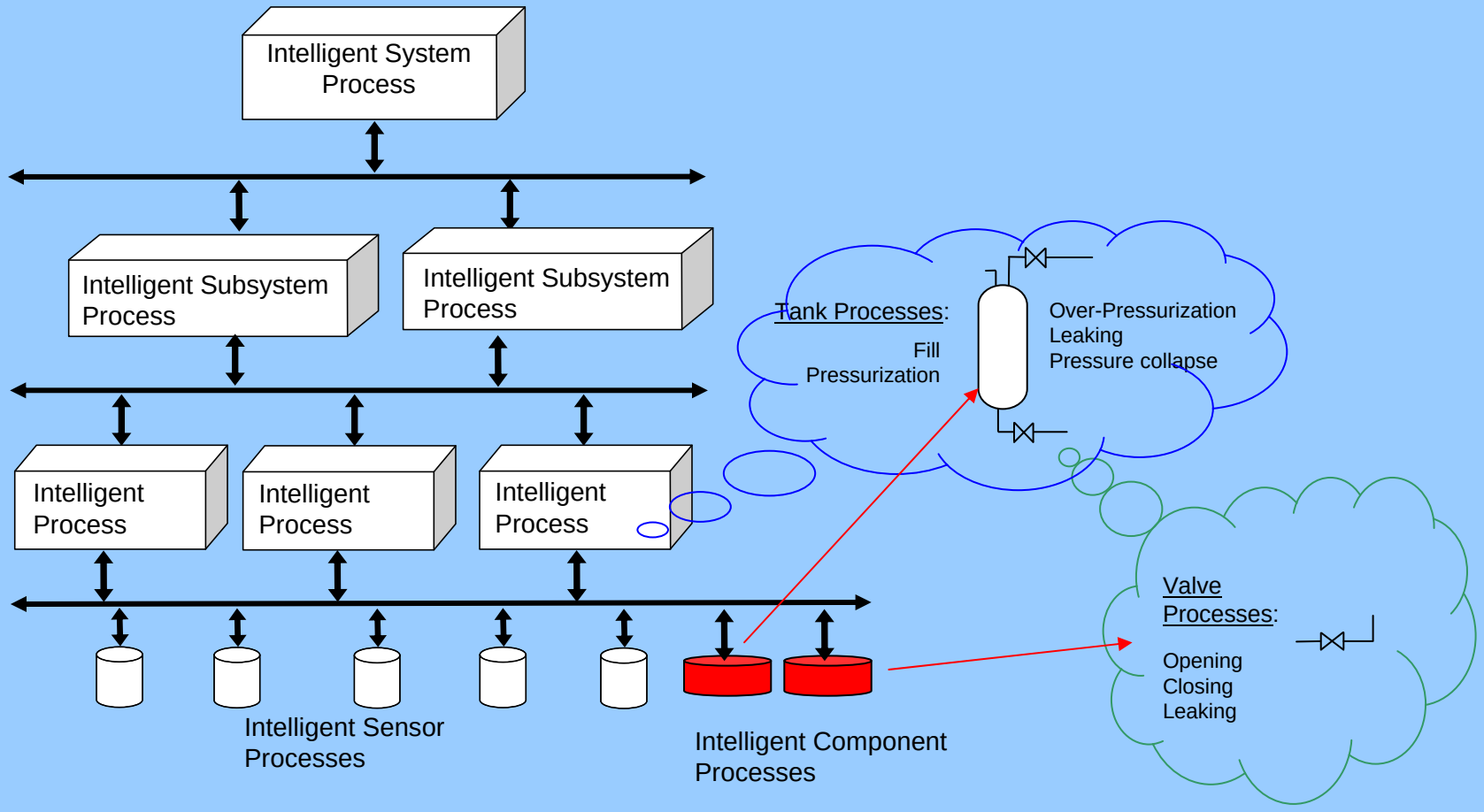
CORE ELEMENTS: ATO for DIaK Management

Process models are generic and are encapsulated within subsystems



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CORE ELEMENTS: ATO for DIaK Management

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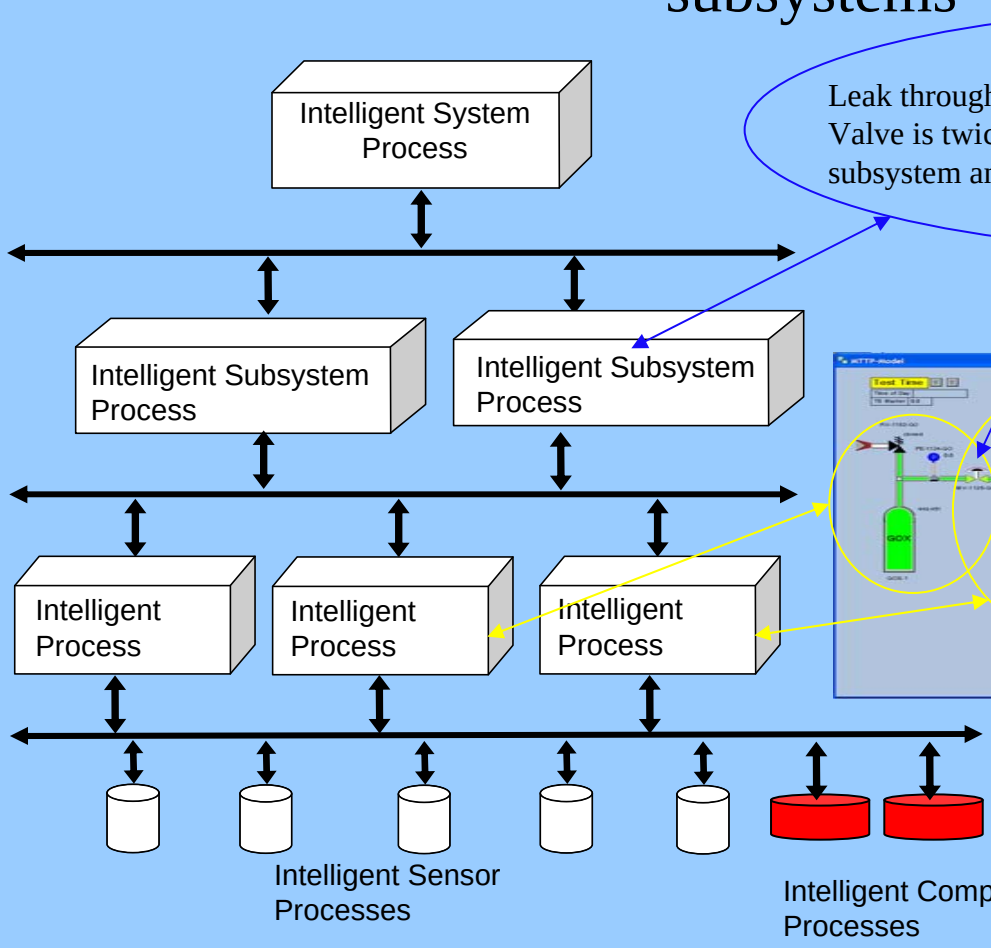
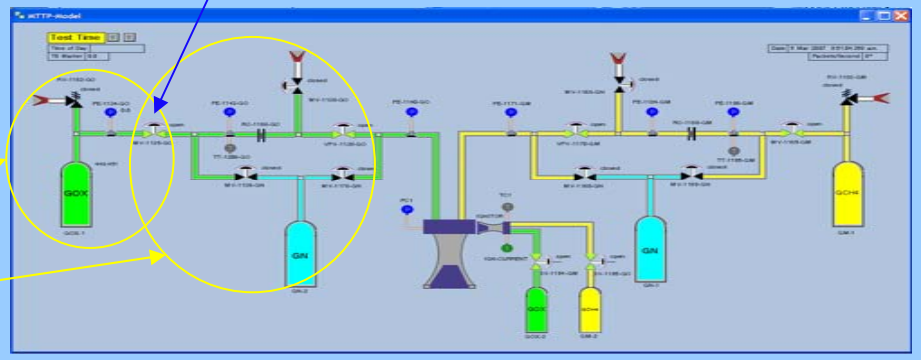


Leak through a valve shared by two pressurizable subsystems: (1) Valve is twice suspect, and (2) If pressure increases in one subsystem and decreases in the other, then Valve is leaking.



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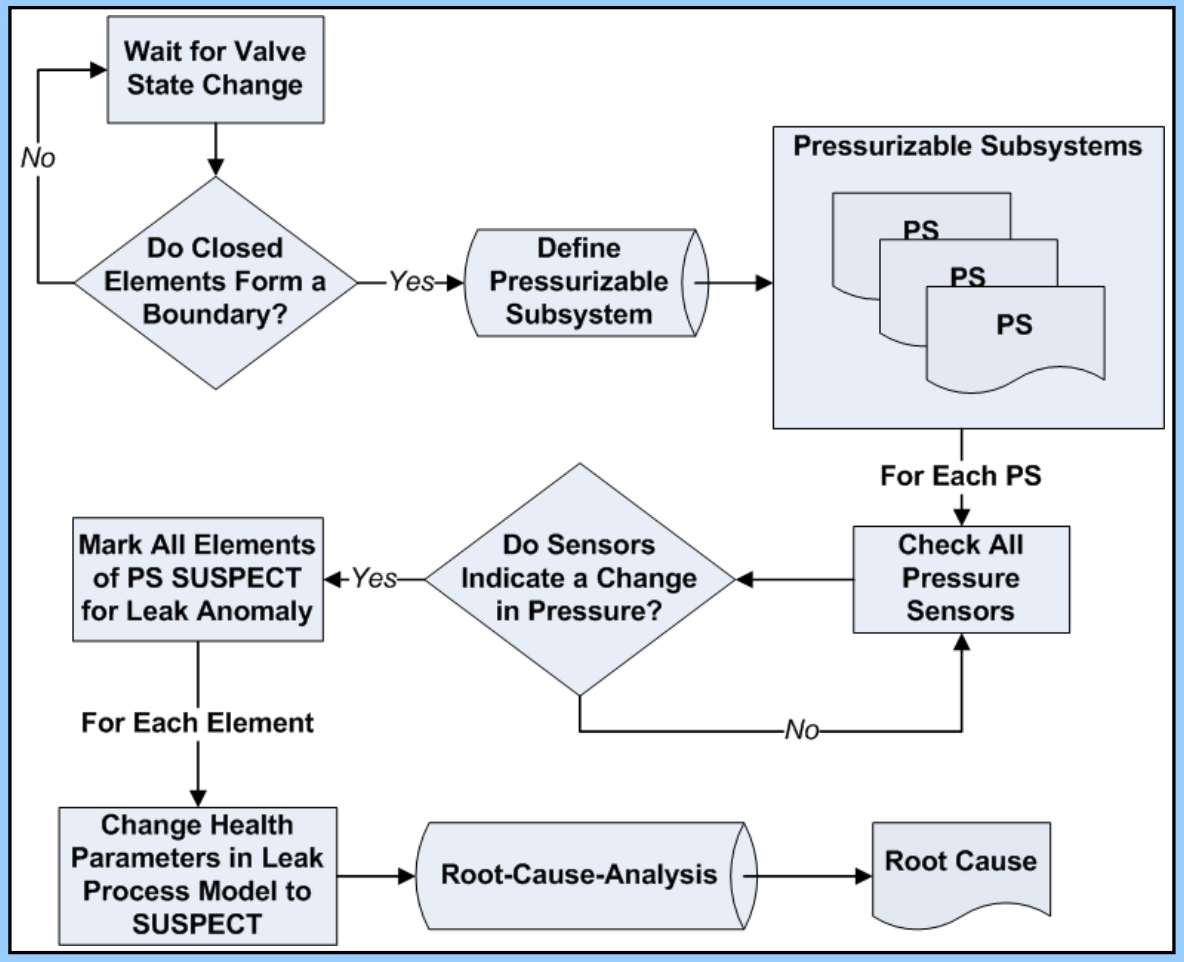
Checking for Pressure Leaks:
Continuous and Comprehensive Vigilance



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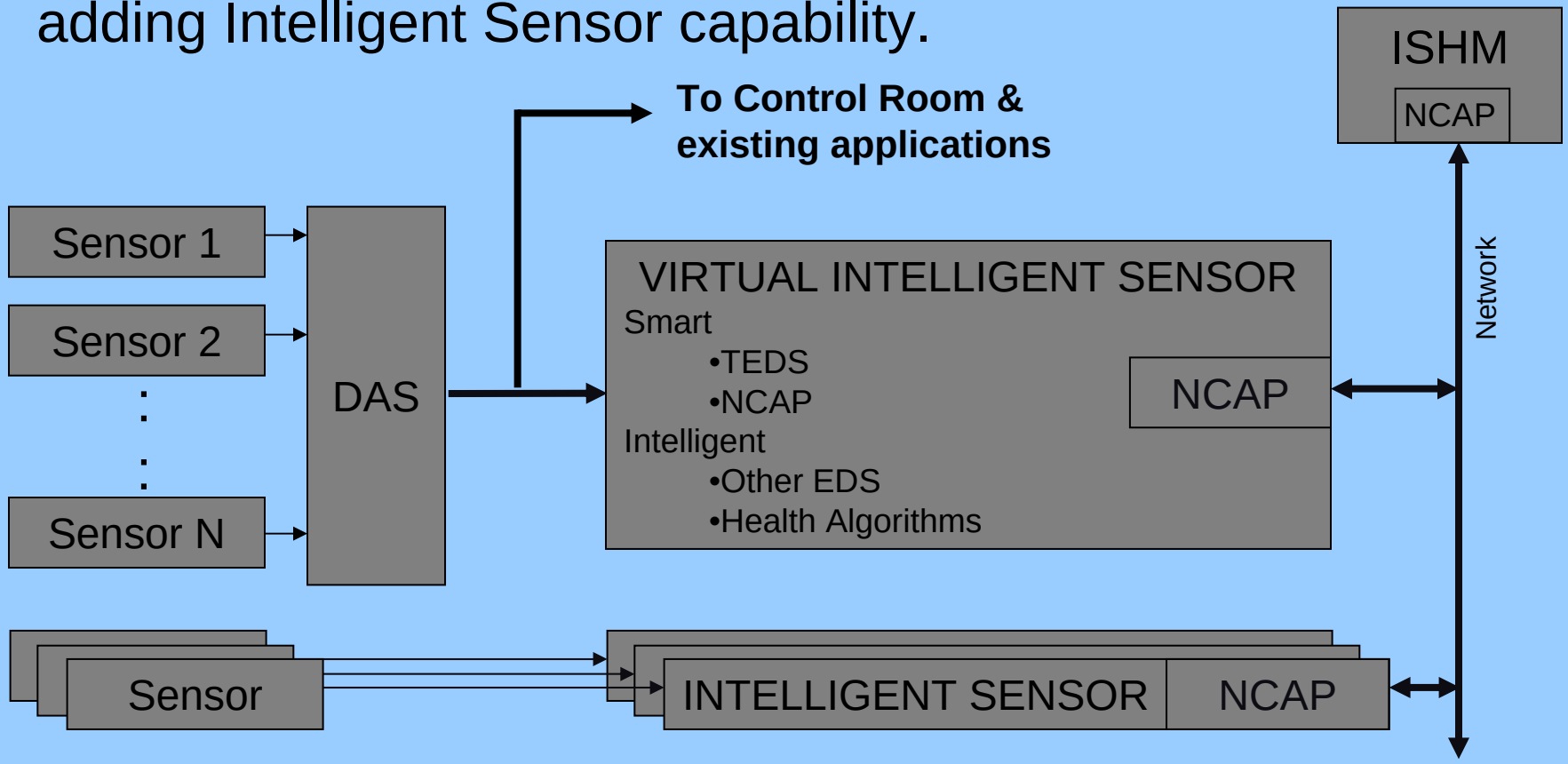
Intelligent Sensors: Virtual and Physical

- Virtual Intelligent Sensors provide benefits of ISHM capabilities to existing data acquisition systems by adding Intelligent Sensor capability.



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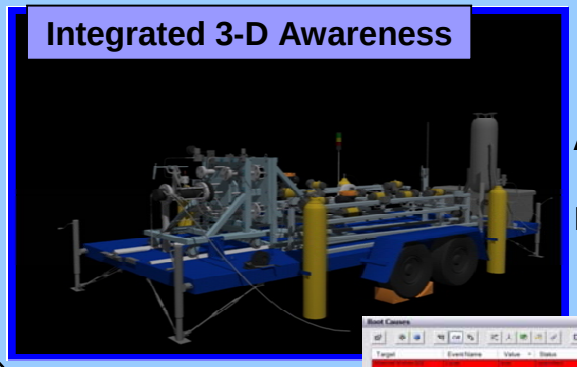
Execution of Fault Management

(Courtesy of General Atomics Corporation)

Measured upstream and downstream pressures

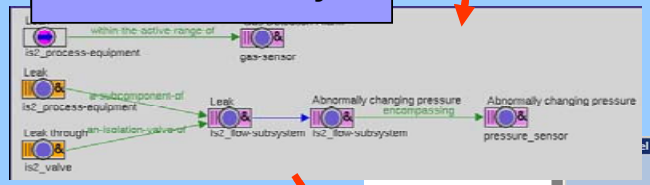
Smart Sensors

Integrated 3-D Awareness

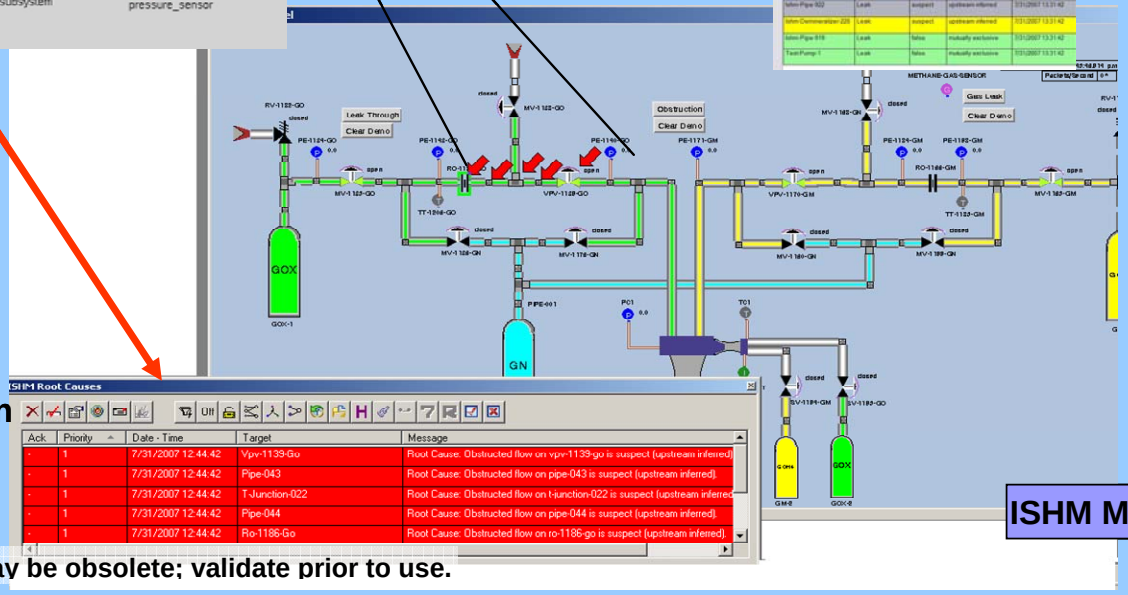


Alarm notification & Recommendation

Root Cause Analysis



Diagnosis Manager Analyzes Events



Inferred Obstruction of flow

ISHM Model

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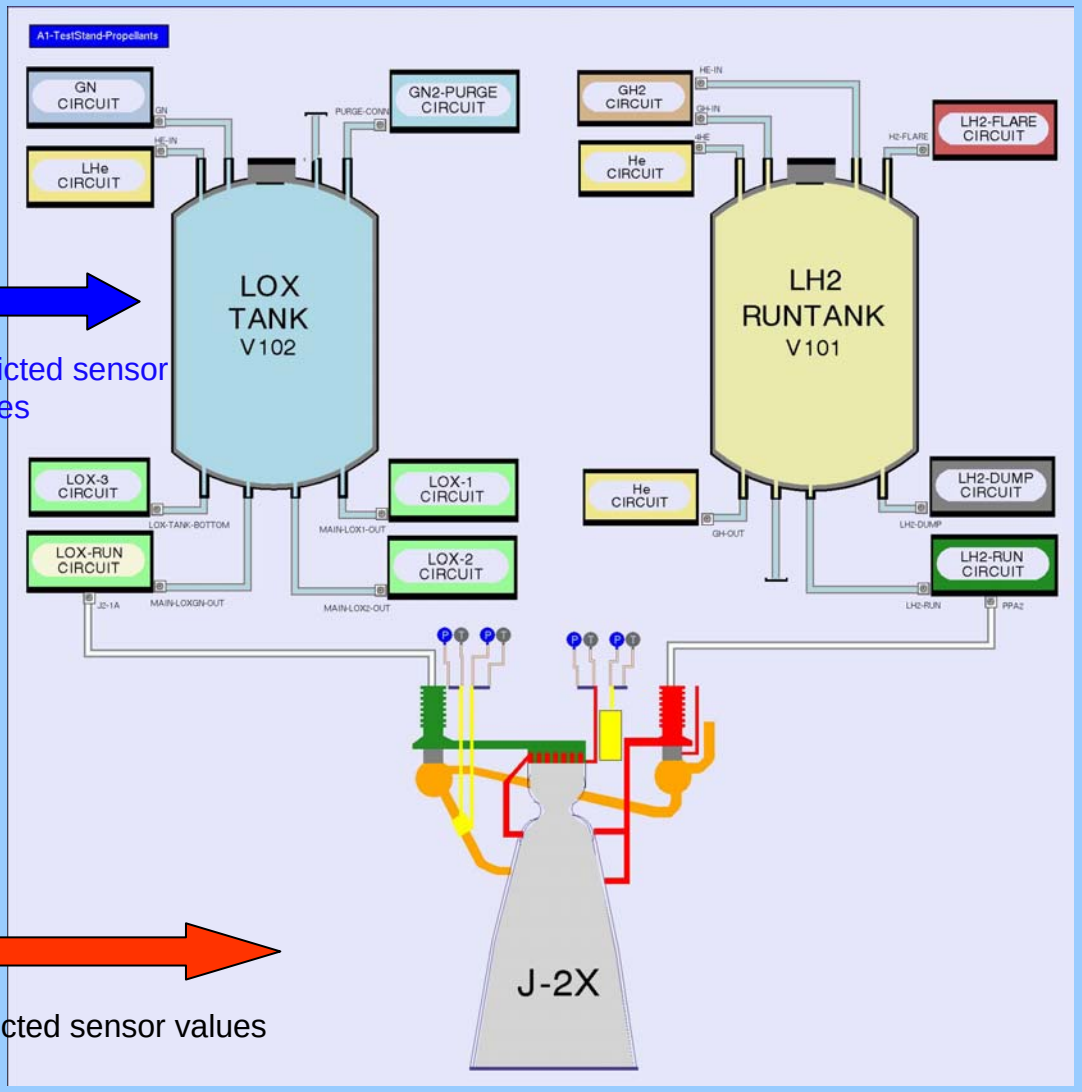
Field Pilot Implementation
A1 and J-2X IFM MODEL

A-1 Test Stand at SSC

Transient Model
Real-Time

Predicted sensor values



J-2X Engine

Predicted sensor values

PWR Transient Model
Real-Time

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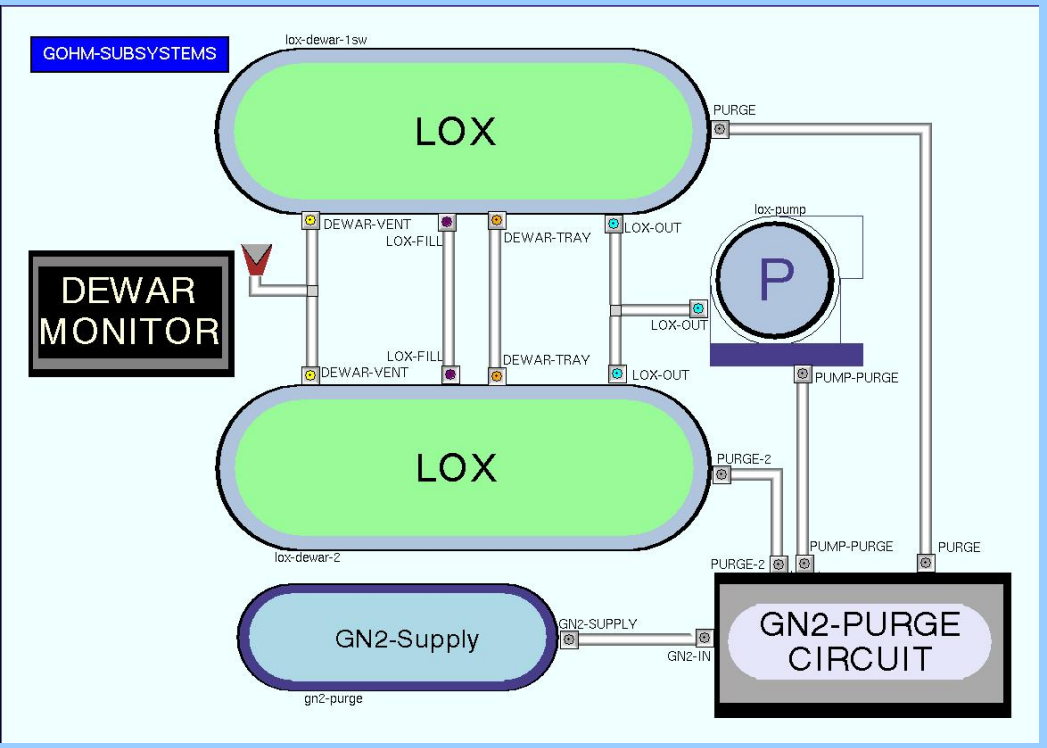
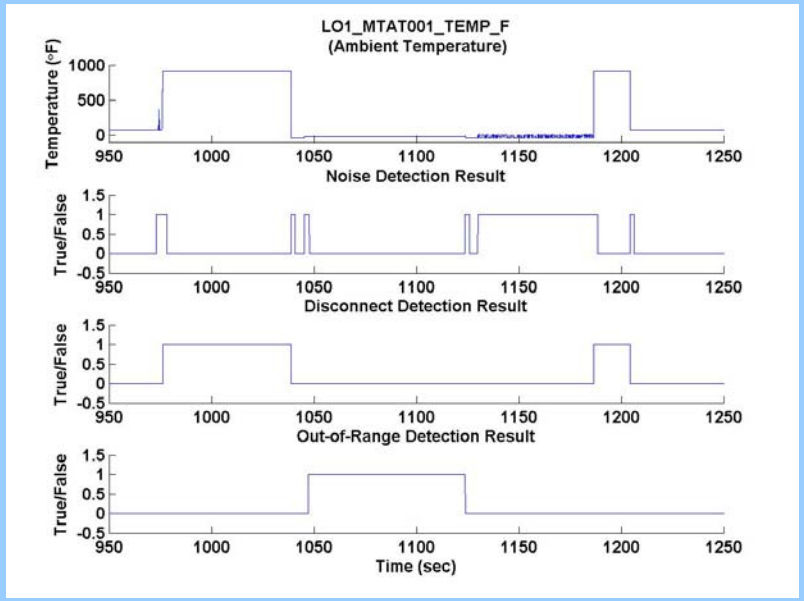
Field Pilot Implementation
GROUND OPERATIONS HEALTH MANAGEMENT (GOHM)

LC-20 ISHM Model (KSC)



Sensor anomalies detected during the demonstration



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NASA SSC ISHM TECHNOLOGIES AND PARTNERSHIPS FOR ROCKET ENGINE TESTING

PENNSTATE

NASA KSC

Open Systems Architectures

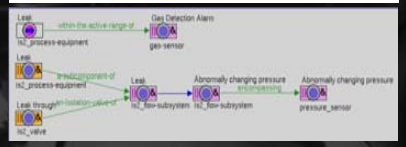
Rocket Engine Test Stand

Prognostics & Anomaly Detection

Pratt & Whitney
A United Technologies Company

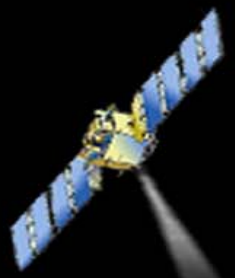
NASA ARC

GENERAL ATOMICS
ELECTROMAGNETIC SYSTEMS



Root Cause Analysis

Test Article



Integrated Awareness

IEEE 1451 Smart & Intelligent Sensors

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NASA KSC

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plug-and-play

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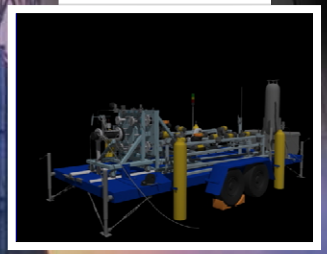

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